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TITLE: Multiple device scan chain emulation/debuggingAbstract Text (1):

A method and system is provided for emulating individual JTAG devices in a multiple device boundary scan chain. The method includes coupling an emulator to the scan chain, and obtaining the topology of the scan chain. One device within the scan chain is then selected, and at least one other device within the scan chain is placed into bypass mode. Emulation instructions are sent to the scan chain, so that the emulation instructions bypass the at least one other device and are executed by the one device.

Brief Summary Text (10):

According to an embodiment of this invention, a method is provided for emulating individual JTAG devices in a multiple device boundary scan chain. The method includes coupling an emulator to the scan chain, and obtaining the topology of the scan chain. One device within the scan chain is then selected, and at least one other device within the scan chain is placed into bypass mode. Emulation instructions are sent to the scan chain, so that the emulation instructions bypass the at least one other device and are executed by the one device.

Brief Summary Text (11):

In another aspect, the present invention includes a graphical user interface (GUI) for an emulator configured to emulate individual JTAG devices in a multiple device boundary scan chain. The GUI includes a user-selectable list of devices, a graphical display of the scan chain, and at least one scan chain parameter field.

Brief Summary Text (12):

A further aspect of the present invention includes a system for emulating individual JTAG devices in a multiple device boundary scan chain. The system includes an emulator couplable to the scan chain, and a topology module configured to obtain the topology of the scan chain. The system also includes a selection module configured to select one device within the scan chain, and a bypass module configured to place at least one other device within the scan chain into bypass mode. An emulation instruction module is configured to send emulation instructions to the scan chain, so that the emulation instructions bypass the at least one other device and are executed by the one device.

Brief Summary Text (13):

A still further aspect of this invention includes an article of manufacture for emulating individual JTAG devices in a multiple device boundary scan chain, the article of manufacture including a computer usable medium having a computer readable program code embodied therein. The computer usable medium includes computer readable program code configured for integration with an emulator, the emulator being couplable to the scan chain. This aspect further includes computer readable program code for obtaining the topology of the scan chain, and computer readable program code for selecting one device within the scan chain. Computer readable program code is also provided for placing at least one other device within the scan chain into bypass mode. Computer readable program code is also provided for sending emulation instructions to the scan chain, so that the emulation

instructions bypass the at least one other device and are executed by the one device.

Detailed Description Text (3):

Embodiments of the present invention include an emulator 110 and software therefor, which enables devices on a multiple device scan chain to be individually targeted for emulation/debugging operations. Particular embodiments of the present invention include JTAG compliant instructions that utilize boundary scan input and output cells to selectively bypass individual devices in the serial scan chain, to enable one or more selected devices to be coupled through the scan chain to the emulator/debugger 110. Examples of JTAG enabled (also referred to as JTAG compliant) devices that may be used in conjunction with embodiments of the present invention include the 6xx, 7xx and 8xx family of processors available from Motorola.RTM. (Palatine, Ill.), as well as POWERPC.RTM. (International Business Machines Corporation 'IBM', Armonk, N.Y.), 4xx (IBM), MIPS.RTM. (Mips Technologies, Inc., Mountain View, Calif.), and ARM (Arm Limited, Cambridge, England) processors.

Detailed Description Text (30):

The counters of these embodiments serve to hold the BYPASS overhead required to isolate a single device on multiple device scan chain 62. When communicating with any IEEE 1149.1 device, there are 2 phases that need to be maintained, an INSTRUCTION phase and a DATA phase. The changes that need to be made to each of these 2 phases are discussed below.

Detailed Description Text (35):

For multiple device scan chains 62, the DEVNUM (and DEVALT) value is broken up into 5 fields as shown in Table 1 below. The first 4 fields of the DEVNUM/DEVALT are the counters that position the selected device 30, 30', etc., on the scan chain 62 as discussed hereinabove. The fifth field is reserved for various commands.

Detailed Description Text (49):

Referring now to FIG. 7B, an exemplary method for emulating individual JTAG devices in a multiple device boundary scan chain in accordance with the teachings of the present invention is discussed. As shown, this method includes coupling 170 emulator 110 (FIGS. 7A and 7C) to the scan chain, and obtaining 172 the topology of the scan chain 62, 62' (FIGS. 6 & 7A), e.g., using topology module 171 (FIG. 7C). This obtaining 172 may be effected by the user inputting the information. Alternatively, module 171 (FIG. 7C) may automatically 174 determine the topology in the manner described hereinabove. The method further includes selecting 176 one device 30 (FIG. 7A) within the scan chain, such as by using selection module 175 (FIG. 7C). As shown in phantom, selecting 176 may optionally include generating 178 a selection instruction such as described hereinabove, and sending 180 the selection instruction to the scan chain. The method further includes placing 182 at least one other device 30' within the scan chain 62 into bypass mode, using bypass module 181 (FIG. 7C). As also shown in phantom, placing 182 may optionally include generating 184 a bypass instruction such as described hereinabove, and sending 186 the bypass instruction to the scan chain. The skilled artisan will recognize that the selecting 176 and placing 182 steps need not be effected in any particular order. Once steps 176 and 182 have been completed, emulation instructions may be sent 188 (e.g., using emulation instruction module 187 of FIG. 7C) to the scan chain, which may then bypass the other device 30' and are executed by the one device 30. In a particular optional embodiment, step 188 may include placing 190 the one device 30 into data mode, and/or formatting 192 the emulation instructions to compensate for the other device(s).

CLAIMS:

1. A method for emulating individual devices in a multiple device chain, said method comprising: obtaining the topology of the chain; selecting one device within

the chain by generating a selection instruction and sending the selection instruction to the chain; placing at least one other device within the chain into bypass mode; sending emulation instructions to the chain, wherein the emulation instructions bypass the at least one other device and are executed by the one device; wherein the individual devices comprise JTAG devices and the chain includes a boundary scan chain; and wherein the selection instruction comprises; an Instruction Register Header field to retain the number of instruction register bits upstream of the one device in the scan chain; an Instruction Register Tail field to retain the number of instruction register bits downstream of the one device in the scan chain; a Data Register Header field to retain the number of devices upstream of the one device in the scan chain; a Data Register Tail field to retain the number of devices downstream of the one device in the scan chain; and a Command field to retain a command for the one device.

7. A method for emulating individual devices in a multiple device chain, said method comprising; obtaining the topology of the chain; selecting one device within the chain; placing at least one other device within the chain into bypass mode by generating bypass instruction and sending the bypass instruction to the scan chain; sending emulation instructions to the chain, wherein the emulation instructions bypass the at least one other device and are executed by the one device; wherein the individual devices comprise JTAG devices and the chain includes a boundary scan chain; and wherein the bypass instruction comprises; an Instruction Register Header field to retain the number of instruction register bits upstream of the other device in the scan chain; an Instruction Register Tail field to retain the number of instruction register bits downstream of the other device in the scan chain; a Data Register Header field to retain the number of devices upstream of the other device in the scan chain; a Data Register Tail field to retain the number of devices downstream of the other device in the scan chain; and a Command field to retain a command for the one device.

28. A system for emulating individual JTAG devices in a multiple device boundary scan chain, said system comprising: a topology module configured to obtain the topology of the scan chain; a selection module configured to select one device within the scan chain; a bypass module configured to place at least one other device within the scan chain into bypass mode; and

an emulation instruction module configured to send emulation instructions to the scan chain, wherein the emulation instructions bypass the at least one other device and are executed by the one device;

wherein the bypass module is configured to generate a bypass instruction including: an Instruction Register header field to retain the number of instruction register bits upstream of the other device in the scan chain; an Instruction Register Tail field to retain the number of instruction register bits downstream of the other device in the scan chain; a Data Register Header field to retain the number of devices upstream of the other device in the scan chain; a Data Register Tail field to retain the number of devices downstream of the other device in the scan chain; and a Command field to retain a command for the one device.

29. An article of manufacture for emulating individual JTAG devices in a multiple device boundary scan chain, said article of manufacture comprising: a computer usable medium having a computer readable program code embodied therein, said computer readable program code including instructions for: obtaining a topology of the scan chain; selecting one device within the scan chain; placing at least one other device within the scan chain into bypass mode; and sending emulation instructions to the scan chain, wherein the emulation instructions bypass the at least one other device and are executed by the one device; wherein said instructions for placing include a bypass instruction including: an Instruction Register Header field to retain the number of instruction register bits upstream of the other device in the scan chain; an Instruction Register Tail field to retain

the number of instruction register bits downstream of the other device in the scan chain; a Data Register Header field to retain the number of devices upstream of the other device in the scan chain; a Data Register Tail field to retain the number of devices downstream of the other device in the scan chain; and a Command field to retain a command for the one device.

30. Computer readable program code for emulating individual JTAG devices in a multiple device boundary scan chain, said computer readable program code comprising instructions to perform the following steps: obtaining the topology of the scan chain; selecting one device within the scan chain; placing at least one other device within the scan chain into bypass mode; and

sending emulation instructions to the scan chain, wherein the emulation instructions bypass the at least one other device and are executed by the one device;

wherein the instructions for placing include a bypass instruction including: an Instruction Register Header field to retain the number of instruction register bits upstream of the other device in the scan chain; an Instruction Register Tail field to retain the number of instruction register bits downstream of the other device in the scan chain; a Data Register Header field to retain the number of devices upstream of the other device in the scan chain; a Data Register Tail field to retain the number of devices downstream of the other device in the scan chain; and a Command field to retain a command for the one device.

31. A system for emulating individual JTAG devices in a multiple device boundary scan chain, said system comprising: a topology module configured to obtain the topology of the scan chain; a selection module configured to select one device within the scan chain; a bypass module configured to place at least one other device within the scan chain into bypass mode; an emulation instruction module configured to send emulation instructions to the scan chain, wherein the emulation instructions bypass the at least one other device and are executed by the one device; at least one register configured to receive selection and bypass instructions respectively generated by the selection and bypass modules; and a graphical user interface (GUI) including: a user-selectable list of JTAG devices; a graphical display of the scan chain; and at least one scan chain parameter field.

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